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TITLE OF THE INVENTION

VERTICAL TRANSPORT LIFT FOR MOVING CONTAINERS FROM DECK TO DECK IN A COMMERCIAL AIRCRAFT

PRIORITY CLAIM

This application is based on and claims the priority under 35 U.S.C. §119 of German Patent Application 103 07 957.2 filed on February 24, 2003, the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The invention relates to a vertical overhead lift system for vertically transporting containers, particularly food and supply containers, from one deck to another in a commercial aircraft. The overhead lift is equipped with a plurality of gripping mechanisms for seizing a container and moving it vertically between two decks.

BACKGROUND INFORMATION

Particularly, in connection with jumbo commercial aircraft there is a need for storing supply containers such as food containers, referred to herein as receptacles, not only on the cabin deck, but also on the loading deck in the freight space below the cabin deck. It is preferred to store as many supply receptacles, particularly food receptacles on the lower deck in order to gain passenger space on the cabin deck. The basic conventional solution to the foregoing preference is to store food, beverages, and goods for sale to passengers in special receptacles which in turn are stored in lower deck freight containers having standard dimensions or standard cross-sectional dimensions, for example size LD6. The receptacles are then lifted out of the container by a vertical lift to an on board galley location on the cabin floor. The receptacles which are initially stored in the freight container are, for example lightweight boxes or wheel equipped trolleys for transporting food along the alleys of the passenger cabin. Transport cages holding several food receptacles may also be stored in the freight containers.

When loading an aircraft, the food and supply container in the form of a special freight container can be handled just as any other freight container and is thus moved into the freight space through an under-deck freight door. However, attention is paid to place the food holding freight container into a position below a galley. Thus, in front of or behind the food holding freight container other freight containers may be positioned on the

freight deck. This is possible because during the loading the cross-sectional area of the freight space is not impaired by the food or supplies holding freight container as long as the latter is handled in its proper sequence for vertical alignment with a galley on the cabin deck. This proper sequence allows to provide the aircraft with but one freight door for each freight space. Further, vertical lifts must be so positioned on the cabin deck, that these lifts do not interfere with the horizontal loading motions on the freight space.

Germany Patent Publication DE 199 55 801 A1 shows, for example, a vertical transport lift equipped with a vertical mast and a transport basket movable up and down the mast. In one conventional lift construction a support plane is positioned below the lower mast mounting so that the transport basket can be lowered onto the support plane. For this lifting and lowering of the transport basket so-called lazy tongue lifts are used, functioning as a second conveying system independently of the lift operating along the mast. The lazy tongues grip the sides of the transport basket, whereby the scissors-type motion of the lazy tongues simultaneously lifts and guides the basket. This type of transport mechanism makes it possible to load and unload supply goods through a flap of the aircraft by vertical up and vertical down movements respectively. Such a conventional additional lazy-type transport mechanism however, does not have any transport safety features which, for example are absolutely necessary when the lazy tongues are to be operated during flight. Details of the function of such a lazy tongue gripper device are

not described in any detail in the above German patent publication.

OBJECTS OF THE INVENTION

In view of the foregoing it is the aim of the invention to achieve the following objects singly or in combination:

to improve a vertical lift for the vertical transport of receptacles in an aircraft in such a way that the gripping of a receptacle is achieved by simple gripper components which nevertheless assure a safe holding of the receptacle, such as a food receptacle;

to assure an automatic motion sequence of the gripping and decoupling actions in response to a small portion of a vertical motion of the vertical lift;

to assure that the gripper mechanism can handle a certain tolerance range with regard to a location where an engagement or a disengagement between lifting hooks and container latches can take place; and

to avoid any interference of the vertical lift with any horizontal conveying system on the lower deck.

SUMMARY OF THE INVENTION

The above objects have been achieved according to the invention by a vertical lift system comprising the following features in combination. A vertical overhead lift on the cabin deck is equipped with a number of gripper mechanisms constructed for cooperation with latch elements of a receptacle to be transported. Each gripper mechanism on the lift cooperates with a corresponding latch element so that the number of gripper mechanism corresponds to the number of latching elements forming part of or attached to the receptacle. Each gripper mechanism comprises a respective lifting hook and a locking pawl which are mechanically coupled to each other in such a way, that the lifting hook locks onto a respective receptacle latch element for locking against forces horizontally effective while the locking pawl engages the receptacle against forces in a vertical direction. Thus, a receptacle, or rather a latch element of a receptacle, is clamped between the hook and the pawl of the respective gripping mechanism.

The gripping mechanism according to the invention provides a simple, yet reliable and tolerance accommodating coupling and decoupling between a receptacle and the vertical lift. The motion sequences of all components are mechanically coupled so that additional sensors and actuators are superfluous. For example, if a container is lowered in such a way that not the entire container bottom contacts the floor underneath simultaneously, the present gripper mechanism in cooperation with

the latch elements assures that different bottom portions of the container may contact the underlying floor in sequence. Hence, some tilting of a receptacle is tolerated. Moreover, the present system is well equipped for cooperation with a horizontal conveying system, whereby again certain tolerances may be compensated. Thus, tolerances are acceptable in the vertical as well as in the horizontal direction between the gripper mechanism and the latching elements.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be clearly understood, it will now be described in connection with example embodiments thereof, with reference to the accompanying drawings, wherein:

Fig. 1 shows a partially broken away side view of a container with a receptacle resting on an intermediate floor of the container, the receptacle is to be lifted vertically upwardly out of the container by a gripping mechanism forming part of a vertical lift (not shown);

Fig. 2 shows on an enlarged scale compared to Fig. 1, the gripper mechanism with a lifting hook engaging a latch element secured to or forming part of the receptacle to be lifted;

Fig. 3 is a perspective view of the primary gripper mechanism components or elements shown in Fig. 2;

Fig. 4A is a view similar to that of Fig. 2 for describing the engagement function of the gripper mechanism whereby the engagement or latching steps have just been completed and the gripper components are shown in a receptacle locking or clamping position;

Fig. 4B is a side view illustrating the beginning of a disengagement of a lifting hook from a latch element of a receptacle after a slight further downward motion of the vertical lift which is only shown symbolically as a box in Fig. 3; and

Fig. 4C shows the fully disengaged position of the gripper mechanism elements following a further downward motion of the vertical lift, whereby the receptacle is ready for removal by a horizontal conveyor system not shown.

DETAILED DESCRIPTION OF PREFERRED EXAMPLE EMBODIMENTS AND OF THE BEST MODE OF THE INVENTION

The side view of Fig. 1 shows a portion of a freight container 1 used as a food supply container that holds a plurality of food or supply receptacles 3, 3'. The freight container 1 sits on the loading floor F in the loading space 2 of an aircraft. The food receptacles 3, 3' rest on an intermediate floor 13 in the container 1. Guides 13' assure that a container 3 is properly aligned below an opening 8 in the container 1 and below a vertical shaft 6 for a lift 71 symbolically shown in Fig. 3. The

shaft 6 defines an open shaft space 5 wherein the lift 71 can move vertically up and down. The loading space 2 extends below the main deck 4 of the aircraft and holds food, freight and supply containers 1. The dimensions of the containers 1 are preferably the same as the dimensions of any other freight container so that handling is facilitated when the containers are moved through a freight door into the loading space 2 including into a space vertically below a galley on the main deck 4. The receptacles 3, 3' have smaller dimensions than the containers 1 and hold food, beverages, and other supply goods. The receptacles 3, 3' may be standard trolleys, boxes, crates or cages, all of which are equipped, according to the invention, with latch elements 9 for cooperation with gripper mechanisms 7 that form part of the vertical lift 71 movable vertically in the Z-direction in the shaft space 5 while the freight containers 1 are movable in the X-, and Y-directions. The vertical lift 71 carries gripping mechanisms 7 each comprising primarily a lifting hook 10 and a locking pawl 11. The number of gripping mechanisms 7 carried by the vertical lift 71 preferably corresponds to the number of latch elements 9 of the receptacles 3, 3'.

Details of the vertical lift 71 symbolically shown in Fig. 3 are conventional, except for the gripping mechanisms 7. A vertical lift is, for instance disclosed in German Patent Publication DE 102 04 892.4. Such lifts are mounted overhead for movement up and down in the lift shaft 6. The shaft 6 is mounted on the cabin floor of the upper deck 4. All structural components of the vertical lift are positioned on the upper deck and out of the

way of any horizontal freight conveyors on the lower deck or floor F. The gripper mechanisms 7 establish automatically an effective connection between the vertical lift 71 and receptacles 3, 3'. The shaft space 5 is so dimensioned that the gripper mechanisms 7 holding a receptacle can freely move into and along the shaft space 5. Similarly, the opening 8 in the freight container 1 is sufficient for the gripping mechanisms 7 to pass into the container 1 for engaging the latch elements 9 of a receptacle. The latch elements 9 are preferably attached to the outer edges 31 or corners of the receptacles 3, 3'. However, it is also possible to integrate the latch elements 9 directly into the receptacles if the structure of the receptacle is feasible for such integration of the latch elements 9 into the side walls of the receptacle 3, 3'. The gripper mechanisms 7 are positioned in vertical alignment with the latch elements 9 when a receptacle 3 is in the proper position as determined by the guides 13'. Further, the receptacles 3, 3' are preferably equipped with guide pads 3A cooperating with respective stationary guides 115 in the shaft space 5.

The function of the gripper mechanisms 7 will now be described, particularly with reference to Figs. 2 and 3 showing a side view and a perspective view of the gripper mechanism 7 respectively. Figs. 2 and 3 show the gripper mechanism 7 in an interlocked engagement with a respective latch element 9. Each gripper mechanism 7 comprises a lifting hook 10 and a locking pawl 11 as mentioned above. The hook 10 is journalled to a portion 71 of the vertical lift by a journal 102. The locking pawl 11 is

journalled to the lift portion by a journal 112 in a position for cooperation with the hook 10. The lift portion 71 is preferably part of a lift slide of the vertical lift. The lifting hook 10 and the locking pawl 11 are mechanically coupled to each other, so that no electrical or mechanical sensors are required for controlling the hook and pawl motions. A claw 103 of the lifting hook 10 can engage a respective recess 92 in the latch element 9 whereby a certain tolerance in the position of the latch elements 9 relative to the hook 10 can be compensated. A stationary activating member 12 is mounted in the lift shaft 6 in such a position that the member 12 can cooperate with a cam track 113 of the locking pawl 11. As the vertical lift slide portion 71 moves downwardly in the direction of the arrow A, the locking pawl 11 will contact with its cam track 113 the stationary activating member 12 that is preferably secured to one of the stationary guides 115 as shown in Fig. 2. The stationary guides 115 are secured to the inner wall of the lift shaft 6. As the downward movement of the lift slide continues, the locking pawl 11 will rotate in the direction of the arrow A1 about the journal 112, thereby disengaging the free end 11A of a downwardly reaching arm 111 of the pawl 11 from an upwardly facing edge portion 31A of the receptacle edge 31 since the downwardly reaching arm 111 of the pawl 11 moves with the pawl 11 in the direction of the arrow A1. The downward movement of the lift slide may be indicated by a pointer P on an indicator scale I shown in Fig. 2.

Referring further to Figs. 2 and 3, the activating member 12 of the shown embodiment is a contact bolt which engages the above mentioned cam track 113 of the locking pawl 11. As the lift keeps moving downwardly in the direction of the arrow A, the pawl 11 will slide with its cam track 113 along the bolt activating member 12 which is preferably rotatable about a fixed axis. In a preferred embodiment the activating member 12 is an integral component of the stationary guide 115 which extends longitudinally inside the shaft space 5 of the lift shaft 6. Alternatively, the activating member 12 may be secured to the guide 115. In both instances the guide 115 assures that the locking pawl 11 is properly guided, for example by the engagement of a pin 11B secured to the pawl 11 for traveling along the guide 115, preferably under a biasing force 141 directed from right to left in Fig. 2. Thus, when the cam track 113 travels downwardly along the stationary activating member 12 the biasing force 141 will make sure that the cam track 113 remains engaged with the activating member 12. Accordingly, uncontrolled movements of the locking pawl 11 are prevented. Thus, the locking pawl 11 cannot unlock itself accidentally.

The locking pawl 11 is operatively coupled with the lifting hook 10 through a contact arm 114 of the pawl 11. As the pawl 11 rotates in the direction of the arrow A1 the contact arm 114 will engage an entraining pin 101 of the lifting hook 10 after the arm 111 of the pawl 11 is disengaged with its free end 11A from the upwardly reaching portion 31A of the receptacle edge 31. At this point the receptacle 3 is freely movable upwardly since the latch

element 9 has been released from the clamping force exerted by the arm 111 of the pawl 11 and the claw 103 of the hook 10 when the gripping mechanism 7 is fully engaged with the latch element 9. However, when the arm 111 disengages from the edge portion 31A the container 3 actually rests on the intermediate floor 13. As a result, the hook 10 can also be disengaged, which is accomplished by the contact arm 114 of the pawl 11 as it engages the entraining pin 101 of the hook 10, thereby rotating the hook 10 about its journal point 102 also in the direction of the arrow A1. At this point the vertical lift may move slightly downwardly for facilitating the full disengagement of the claw 103 from the pawl recess 92 as will be described in more detail below with reference to Figs. 4A, 4B and 4C, wherein Fig. 4A shows a full engagement of the hook 10 with the latch 9 as in Fig. 2, while Fig. 4B shows a partially disengaged state, and Fig. 4C shows a fully disengaged state.

As shown in Fig. 4A the cam track 113 has not yet contacted the activating member 12. Thus, the hook 10 of the gripper mechanism 7 is in full engagement with the latch element 9. Resets 14 providing required reset forces such as 141 and 142 are effective on the pawl 11 and on the hook 10 respectively in order to keep the claw 103 of the hook 10 engaged with the latching element 9. The resets 14 may be accomplished, for example by biasing springs 141, 142, such as spiral springs or expansion springs, or gas pressure springs which are effective to exert a torque moment around the journal points 102 and/or 112. Any other suitable biasing force generating elements may also be used which assure

a positive engagement of the hook 10 of the gripping mechanism 7 with the latch element 9 of a receptacle as long as the activating member 12 is not effective, that is when the lift is in positions in which the cam track 113 cannot engage the activating member 12. The reset or biasing force 141 is effective on the locking pawl 11 in the direction from right to left in Fig. 2. The reset or biasing force 142 is effective on the lifting hook 10 also from right to left and both reset or biasing forces generate a holding or locking moment that keeps the hook 10 and latch 9 engaged as described above.

Fig. 4B illustrates the position in the further downward motion of the lift 71 in the direction of the arrow A. As the stationary activating member 12 engages the downwardly moving cam track 113, the downwardly reaching arm 111 of the pawl 11 tilts to the left in Fig. 4B against the reset or biasing force 141, thereby releasing the upper edge portion 31A of the upper edge 31 of the receptacle 3. At this point the receptacle 3 rests on the intermediate floor 13 shown in Fig. 1 of the freight container 1. As the lift 71 moves slightly further down as indicated by the different positions of the pointer P relative to the indicating scales I in Figs. 4A, 4B and 4C, the claw 103 of the hook 10 slides down a disengaging ramp 91 of the latch 9 against the biasing force 142. The motion of the claw 103 along the disengagement ramp 91 begins before the contact arm 114 of the claw 11 engages the entraining pin 101 of the hook 10. Thus, the claw 103 is shifted out of the recess 92 of the latch 9 to move the hook 10 and the claw 11 into the positions shown in

Fig. 4C. The pointer P has now reached its substantially lowest point on the indicator scale I.

Fig. 4C shows the completely disengaged position of the gripper mechanism 7 from the latch 9 with the receptacle 3 still fully resting on the floor 13. In this position the container 3 can be moved horizontally either in the X- or preferably in the Y-direction out of the lift alignment position shown in Fig. 1.

The portion of the downward lift motion from the middle position shown in Fig. 4B to the fully down position shown in Fig. 4C makes it possible that a certain tolerance between the latch 9 and the hook 10 is permissible. More specifically, it is, for example, possible that not the entire surface area of the container bottom touches simultaneously the intermediate floor 13. Thus, one corner or one edge can touch first and the other edges or corners may then touch the intermediate floor in sequence.

It has been found that a satisfactory cooperation of the gripper mechanism 7 components 10, 11 with the latch elements 9 is achieved if the journal points 102 of the hook 10 and 112 of the claw 11 form two corner points of a parallelogram. The other two corner points of the parallelogram are formed by the downwardly facing end of the arm 111 and by the tip of the claw 103 when the claw tip and the lower end of the arm 111 are engaged with the latch recess 92 and the edge portion 31A respectively.

The gripping mechanism 7 according to the invention is self-adjusting and makes possible that the receptacle 3 can orient itself in the X-direction, whereby an adaptation of the receptacle, or rather of its positional orientation relative to a horizontal guide system, becomes possible. A change in the kinematic conditions is also be possible. More specifically, it is for example possible to change the distances between the journal points 102 and 112 and/or to change the shape of the cam track 113 or the shape of the contact arm 114 to thereby obtain a different motion pattern compared to the above mentioned parallelogram motion. Such possible adaptations facilitate the cooperation of the vertical lift transport with any horizontal transportation system on the loading floor.

The above description shows how a receptacle 3 is lowered from the upper deck 4 down back into a container 1. In order to transport a receptacle 3 from the lower deck to the main deck 4 the above described sequences or steps proceed in the opposite sequence. Further, it is possible that a full opening of the lifting hook 10 and of the locking pawl 11 is not necessary for a renewed engagement operation, which is contrary to what is shown in Fig. 4C. For this purpose the lift hook 10, or rather the claw 103 of the lift hook 10 can ride along an engagement ramp 93 as the vertical lift moves downwardly along the container 3 standing on the intermediate floor 13. As soon as the claw 103 runs off the ramp 93 the biasing force 142 will assure that the claw 103 engages the recess 92 and the lower end 11A of the locking arm 111 engages the upper edge portion 31A of the

receptacle edge 31. Due to the reset or biasing forces 141 and 142 the lifting hook 10 and the locking pawl 11 are automatically shifted into and held in the interlocking position shown in Fig. 4A. Now the lift 71 can move the receptacle 3 from the lower floor or out of the container 1 to the main deck 4.

Although the invention has been described with reference to specific example embodiments, it will be appreciated that it is intended to cover all modifications and equivalents within the scope of the appended claims. It should also be understood that the present disclosure includes all possible combinations of any individual features recited in any of the appended claims.